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[Title of the Invention]

Liquid Crystal Display Device and Manufacturing Method thereof

[Abstract]

[Problem] There is a problem in that, due to numerous photolithography steps, a manufacturing process is complicated, a manufacturing cost is raised, and a manufacturing yield is lowered.

[Solving Means] Together with using a channel etching type thin film transistor, an insulation protective film is formed so as to cover the thin film transistor and image signal wiring. A part of the image signal wiring is exposed at an outlet terminal portion of the image signal wiring. Part of scanning signal wiring is exposed at an outlet terminal portion of the scanning signal wiring. A surface layer of the scanning signal wiring is formed of an aluminum alloy with a refractory metal added thereto or is formed of a refractory metal having energy of oxide formation of -300 kcal or more.

[Scope of Claim]

[Claim 1] A liquid crystal display device, in which a plurality of image signal wirings and a plurality of scanning signal wirings are provided so as to intersect each other through an insulating film, pixel electrodes and reverse stagger type thin film transistors for supplying an image signal to said pixel electrodes are provided so as to be matrix-like at intersections of said image signal wirings and said scanning signal wirings, and a liquid crystal material is held between said pixel electrodes and an opposing electrode provided so as to be opposed to said pixel electrodes, characterized in that:

said thin film transistors are of a channel etching type;
an insulation protective film is formed so as to cover said thin film transistors and said image signal wirings;

part of said image signal wirings are exposed at outlet terminal portions of said image signal wirings;

part of said scanning signal wirings are exposed at outlet terminal portions of said scanning signal wirings; and

a surface layer of said scanning signal wirings is formed of an aluminum alloy with a refractory metal added thereto or is formed of a refractory metal having energy of oxide formation of -300 kcal or more.

[Claim 2] A liquid crystal display device as claimed in claim 1, characterized in that said image signal wirings are laminated films

formed of a high-resistance semiconductor film, a low-resistance semiconductor film, a barrier metal film, and a transparent conductive film, and said transparent conductive film, said barrier metal film, and said low-resistance semiconductor film are patterned to be in a substantially identical shape in channel portions of said thin film transistors.

[Claim 3] A liquid crystal display device as claimed in claim 2, characterized in that a semiconductor film of said thin film transistors is formed of a high-resistance semiconductor film to be a channel layer and a low-resistance semiconductor film to be an ohmic contact layer, and said high-resistance semiconductor film is formed of a lower semiconductor layer not containing nitrogen element and carbon element and an upper semiconductor layer containing nitrogen element or carbon element.

[Claim 4] A liquid crystal display device as claimed in claim 2, characterized in that short circuit wiring for connecting said plurality of image signal wirings through a transistor are provided in a peripheral portion of said display region, and a gate electrode and a source/drain electrode are capacitively coupled to each other through said insulating film.

[Claim 5] A liquid crystal display device as claimed in claim 2, characterized in that said plurality of scanning signal wirings and short circuit ring wiring for discharging static electricity of said plurality of scanning signal wirings are laminated through said insulating film and provided in a peripheral portion of said

display region, and said protective film and said insulating film are removed in said laminated portion to expose part of said short circuit ring wiring and of said scanning signal wirings.

[Claim 6] A liquid crystal display device as claimed in claim 2, characterized in that band-like light-shielding electrodes are provided through said insulating film on a rear surface side of said pixel electrodes, said band-like light-shielding electrodes being protruded from said pixel electrodes on a side of said image signal wirings, formed of a material of said scanning signal wirings, and separated with regard to respective pixels.

[Claim 7] A method of manufacturing a liquid crystal display device comprising the steps of:

providing an aluminum alloy with a refractory metal added thereto or a refractory metal having energy of oxide formation of -300 kcal or more as a surface layer of scanning signal wirings;

providing said scanning signal wrings and image signal wirings so as to intersect each other through an insulating film;

providing pixel electrodes and reverse stagger and channel etching type thin film transistors for supplying an image signal to said pixel electrodes so as to be matrix-like at intersections of said image signal wirings and said scanning signal wirings;

forming an insulation protective film so as to cover said thin film transistors and said image signal wirings; and

injecting a liquid crystal material between said pixel

electrodes and an opposing electrode provided so as to be opposed to said pixel electrodes,

characterized in that patterning of said protective film on said pixel electrodes, patterning of said protective film on outlet terminals of said image signal wirings, and patterning of said protective film and said insulating film of outlet terminal portions of said scanning signal wirings are carried out simultaneously.

[Claim 8] A method of manufacturing a liquid crystal display device as claimed in claim 6, characterized in that said image signal wirings are laminated films formed of a high-resistance semiconductor film, a low-resistance semiconductor film, a barrier metal film, and a transparent conductive film, and said low-resistance semiconductor film, said barrier metal film, and said transparent conductive film are patterned using a same photomask in channel portions of said thin film transistors.

[Claim 9] A method of manufacturing a liquid crystal display device as claimed in claim 7, characterized in that said insulating film is formed of laminated films of a first insulating film and a second insulating film, and, after said first insulating film is formed, said second insulating film, said high-resistance semiconductor film, said low-resistance semiconductor film, and said barrier metal film are formed in succession.

[Claim 10] A method of manufacturing a liquid crystal display device as claimed in claim 9, characterized in that said first insulating

film, said second insulating film, said high-resistance semiconductor film, said low-resistance semiconductor film, and said barrier metal film are formed with part of said scanning signal wirings being masked.

[Detailed Description of the Invention]

[0001]

[Field of the Industrial Application]

The present invention relates to a liquid crystal display device and a method of manufacturing thereof, and in particular, to an active matrix liquid crystal display device having thin film transistors for switching in its pixel portions, respectively, and a manufacturing method thereof.

[0002]

[Prior Art]

An active matrix liquid crystal display device is mainly formed of a TFT array substrate having pixel electrodes and thin film transistors (TFTs) for switching formed thereon and an opposing electrode substrate having an opposing electrode formed thereon.

[0003]

A structure of a conventional TFT array substrate is described with reference to Figs. 8 to 11. Fig. 8 illustrates the electric structure of the conventional TFT array substrate. Fig. 9 is a plan view illustrating a state of one pixel portion. Fig. 10 is a sectional view taken along the line A-A' in Fig. 9 including

an opposing electrode substrate. Fig. 11 is a sectional view taken along the line B-B' in Fig. 9 including the opposing electrode substrate.

[0004]

In Figs. 8 to 11, 31 denotes a scanning signal wiring, 32 denotes an image signal wiring, 33 denotes a pixel electrode, 35 denotes a thin film transistor, 37 denotes a black matrix, 38 denotes an insulating film, 39 denotes a protective film, 40 denotes a liquid crystal material, 41 denotes an opposing electrode, and 42 and 43 denote transparent glass substrates.

[0005]

A plurality of scanning signal wirings 31 and a plurality of image signal wirings 32 are provided on the transparent glass substrate 43 so as to intersect each other through the insulating film 38. The pixel electrodes 33 and the reverse stagger type thin film transistors 35 for supplying an image signal to the pixel electrodes 33 are provided so as to be matrix-like at respective intersections of the scanning signal wirings 31 and the image signal wirings 32. It is to be noted that the thin film transistor 35 is formed of a gate electrode G formed so as to protrude from the scanning signal wiring 31, a gate insulating film formed of the insulating film 38, a high-resistance semiconductor film 36 to be a channel region, a low-resistance semiconductor film 44 to be an ohmic contact layer, a source electrode S, and a drain electrode D. The source electrode S is formed so as to protrude from the image signal wiring

32, and the drain electrode D is formed so as to be connected to the pixel electrode 33.

[0006]

On the transparent glass substrate 42, the black matrix 37 and the opposing electrode 41 are provided. The black matrix 37 is for preventing light leakage between the pixel electrodes 33 of the TFT array substrate. By sandwiching the liquid crystal material 40 between the pixel electrodes 33 and the opposing electrode 41 and by selectively supplying an image signal to the pixel electrodes 33 through the thin film transistors 35, an image is displayed. More specifically, on/off of the thin film transistors 35 is controlled by a scanning signal supplied from the scanning signal wirings 31, and an image signal supplied from the image signal wirings 32 is supplied through the source electrodes S and the drain electrodes D to the pixel electrodes 33.

[0007]

It is to be noted that, as illustrated in Fig. 8, one end portion of each of the scanning signal wirings 31 is connected through wirings 46 to a short circuit ring wiring 49, while one end portion of each of the image signal wirings 32 is connected through thin film transistors 51 and 52 for protection against high voltage to the short circuit ring wiring 49. The short circuit ring wiring 49 is provided to prevent electrostatic destruction of the insulating film 38 and the like during the manufacturing process. The thin film transistor 51 for protection against high voltage is provided

to, by connecting thereto each of the image signal wirings 32 through a resistance having a predetermined value or more, make it possible to inspect a short circuit, disconnection, and the like of each of the image signal wirings 32.

[0008]

A method of manufacturing the TFT array substrate structured in this way is described with reference to Figs. 12 to 14. Fig. 12 illustrates a manufacturing process of the pixel electrode portion. Fig. 13 illustrates a manufacturing process of a portion around an outlet terminal of the scanning signal wiring 31. Fig. 14 illustrates a manufacturing process of a portion around an outlet terminal of the image signal wiring 32.

[0009]

In Figs. 12 to 14, 34 denotes an etching stopper film, 35 denotes the thin film transistor, 38 denotes the insulating film, 39 denotes the protective film, 43 denotes the transparent glass substrate, 44 denotes a low-resistance semiconductor film of the thin film transistor 35, 49 denotes the short circuit ring wiring, 50 denotes an external outlet terminal of the image signal wiring, 51 denotes the thin film transistor for protection against high voltage, 52 denotes a gate electrode of the thin film transistor 51 for protection against high voltage, and 53 denotes an electrode junction portion of the thin film transistor for protection against high voltage.

[0010]

First, the manufacturing process of the pixel electrode 33 is described with reference to Fig. 12. As illustrated in Fig. 12(a), electrodes 31 and 31' of tantalum (Ta) or the like acting both as the scanning signal wiring and a gate electrode of the thin film transistor 35 are selectively formed on the glass substrate 43.

[0011]

Then, as illustrated in Fig. 12(b), the insulating film 38 of silicon nitride or the like is formed, and, the high-resistance semiconductor film 36 of amorphous silicon or the like and the etching stopper film 34 of silicon nitride or the like are formed. After that, the high-resistance semiconductor film 36 and the etching stopper film 34 are simultaneously and selectively etched.

[0012]

Then, as illustrated in Fig. 12(c), patterning is carried out such that the etching stopper film 34 has a smaller area.

[0013]

Then, as illustrated in Fig. 12(d), the low-resistance semiconductor film 44 of amorphous silicon film with impurity doped therein or the like is formed and selectively etched.

[0014]

Then, as illustrated in Fig. 12(e), the pixel electrode 33 of a transparent conductive film (ITO) or the like is selectively formed.

[0015]

Then, as illustrated in Fig. 12(f), by forming and patterning a metal film of chromium (Cr) or the like, the image signal wiring 32 and a source electrode (S) and a drain electrode (D) of the thin film transistor 35 are formed.

[0016]

Finally, as illustrated in Fig. 12(g), by forming and patterning the insulation protective film 39 of silicon nitride or the like, the protective film 39 is formed except portions on the pixel electrode 33.

[0017]

Next, the manufacturing process of the portion around the outlet terminal of the scanning signal wiring 31 is described with reference to Fig. 13.

[0018]

First, as illustrated in Fig. 13(a), an end portion of the scanning signal wiring 31 is formed. This is the same step as that illustrated in Fig. 11(a).

[0019]

Then, as illustrated in Fig. 13(b), the insulating film 38 is formed. This is the same step as that illustrated in Fig. 12(b).

[0020]

Then, as illustrated in Fig. 13(c), part of the insulating film 38 is etched to expose part of the scanning signal wiring 31.

This step is carried out between the steps illustrated in Figs. 12(d) and (e).

[0021]

Then, as illustrated in Fig. 13(d), wiring 46 of transparent conductive film (ITO) or the like is formed on the scanning signal wiring 31. The wiring 46 is formed simultaneously with the pixel electrode 33 illustrated in Fig. 12(e).

[0022]

Then, as illustrated in Fig. 13(e), the short circuit ring wiring 49 of chromium (Cr) or the like is formed on the wiring 46. The short circuit ring wiring 49 is formed simultaneously with the image signal wiring 32 illustrated in Fig. 12(f).

[0023]

Finally, the protective film 39 is formed, and part of the protective film 39 is etched and removed such that the wiring 46 is exposed. The formation and etching of the protective film 39 is carried out simultaneously with the step illustrated in Fig. 12(g). In this way, an exposed external outlet terminal 47 is formed.

[0024]

Next, the manufacturing process of the portion around the outlet terminal of the image signal wiring 32 is described with reference to Fig. 14.

[0025]

First, as illustrated in Fig. 14(a), the gate electrode 52 of the thin film transistor 51 for protection against high voltage is formed simultaneously with the scanning signal wiring 31 illustrated in Fig. 12(a).

[0026]

Then, as illustrated in Fig. 14(b), after the high-resistance semiconductor film 36 of the thin film transistor 51 for protection against high voltage and the etching stopper film 34 are formed, the high-resistance semiconductor film 36 and the etching stopper film 34 are simultaneously and selectively etched. This step is the same step as that illustrated in Fig. 12(b).

[0027]

Then, as illustrated in Fig. 14(c), simultaneously with the step illustrated in Fig. 12(c), the etching stopper film 34 is etched to have smaller area.

[0028]

Then, as illustrated in Fig. 14(d), simultaneously with the step illustrated in Fig. 12(d), the low-resistance semiconductor film 44 of the thin film transistor 51 for protection against high voltage is selectively formed.

[0029]

Then, as illustrated in Fig. 14(e), part of the insulating film 38 is etched to expose part of the gate electrode 52. This step is carried out between the steps illustrated in Figs. 12(d)

and (e), simultaneously with the step illustrated in Fig. 13(c).

[0030]

Then, as illustrated in Fig. 14(f), a source electrode (S) and a drain electrode (D) of the thin film transistor 51 for protection against high voltage are formed. This step is carried out simultaneously with the step illustrated in Fig. 12(f). It is to be noted that the source electrode (S) and a gate electrode (G) of the thin film transistor 51 for protection against high voltage are formed to short-circuit through the wiring 32.

[0031]

Then, as illustrated in Fig. 14(g), the protective film 39 is formed on the thin film transistor 51 for protection against high voltage to complete the process. The protective film 39 is formed and patterned simultaneously with the protective film 39 illustrated in Fig. 12(g).

[0032]

[Problem to be solved by the Invention]

However, in the conventional liquid crystal display device described in the above, since the thin film transistor 35 is a thin film transistor provided with the etching stopper film 34, the step of patterning the etching stopper film 34 (Fig. 12(c)) is additionally required, and the step of forming and patterning the low-resistance semiconductor film 44 (Fig. 12(d)) is additionally required. Further, since the transparent conductive film such as ITO is formed

at the terminal portion of the scanning signal wiring 31 and the gate electrode G and the source electrode S of the thin film transistor 51 for protection against high voltage are directly connected, the additional step of forming contact holes in the insulating film 38 at the terminal portion of the scanning signal wiring 31 and at the gate electrode portion 52 of the thin film transistor 51 for protection against high voltage (Figs. 13(c) and 14(e)) is required. Further, since the pixel electrode 33 of a transparent conductive film such as ITO is formed before the image signal wiring 32 and the source electrode S and the drain electrode D of the thin film transistor 35 are formed, the additional step of forming the image signal wiring 32 and the source electrode S and the drain electrode D of the thin film transistor 35 (Fig. 12(f)) is required. Therefore, there is a problem in that the manufacturing process is complicated, the manufacturing cost is raised, and the manufacturing yield is lowered. More specifically, in the manufacturing process of a TFT array substrate in a conventional liquid crystal display device, photomask is required in steps illustrated in Figs. 12(a) - (g) and Fig. 13(c) (Fig. 14(e)), and eight photolithography steps in total are required.

[0033]

The present invention is made in view of the above problem of the prior art, and an object of the present invention is to eliminate the complexity of the manufacturing process, the highness of the manufacturing cost, and the decrease in the manufacturing yield

due to the numerous photolithography steps.

[0034]

[Means for solving the Problem]

In order to attain the above object, in a liquid crystal display device as claimed in claim 1, a plurality of image signal wirings and a plurality of scanning signal wirings are provided so as to intersect each other through an insulating film, pixel electrodes and reverse stagger type thin film transistors for supplying an image signal to the pixel electrodes are provided so as to be matrix-like at intersections of the image signal wirings and the scanning signal wirings, and a liquid crystal material is held between the pixel electrodes and an opposing electrode provided so as to be opposed to the pixel electrodes, and the liquid crystal display device is characterized in that the thin film transistors are of a channel etching type, an insulation protective film is formed so as to cover the thin film transistors and the image signal wirings, part of the image signal wirings are exposed at outlet terminal portions of the image signal wirings, part of the scanning signal wirings are exposed at outlet terminal portions of the scanning signal wirings, and a surface layer of the scanning signal wirings is formed of an aluminum alloy with a refractory metal added thereto or is formed of a refractory metal having energy of oxide formation of -300 kcal or more.

[0035]

A method of manufacturing a liquid crystal display device

as claimed in claim 7 comprising the steps of providing an aluminum alloy with a refractory metal added thereto or a refractory metal having energy of oxide formation of -300 kcal or more as a surface layer of scanning signal wirings, providing the scanning signal wirings and image signal wirings so as to intersect each other through an insulating film, providing pixel electrodes and reverse stagger and channel etching type thin film transistors for supplying an image signal to the pixel electrodes so as to be matrix-like at intersections of the image signal wirings and the scanning signal wirings, forming an insulation protective film so as to cover the thin film transistors and the image signal wirings, and injecting a liquid crystal material between said pixel electrodes and an opposing electrode provided so as to be opposed to said pixel electrodes is characterized in that patterning of the protective film on the pixel electrodes; patterning of the protective film on outlet terminals of the image signal wirings, and patterning of the protective film and the insulating film of outlet terminal portions of the scanning signal wirings are carried out simultaneously.

[0036]

[Embodiment Mode of the Invention]

Embodiments of a liquid crystal display device and a method of manufacturing thereof according to the present invention are now described in detail with reference to the attached drawings.

[0037]

Figs. 1 to 4 illustrate an embodiment of a liquid crystal display device as claimed in claim 1. Fig. 1 illustrates the electric structure of a TFT array substrate. Fig. 2 is a plan view illustrating the TFT array substrate. Fig. 3 is a sectional view taken along the line A-A' in Fig. 2 including an opposing electrode substrate. Fig. 4 is a sectional view taken along the line B-B' in Fig. 2 including the opposing electrode substrate. In Figs. 1 to 4, 1 denotes a scanning signal wiring, 2 denotes an image signal wiring, 3 denotes a pixel electrode, 4 denotes a band-like light-shielding electrode, 5 denotes a thin film transistor, 6 denotes a high-resistance semiconductor film, 7 denotes a black matrix, 8 denotes a gate insulating film, 9 denotes a protective film, 10 denotes a liquid crystal material, 11 denotes an opposing electrode, and 12 and 13 denote transparent glass substrates.

[0038]

A plurality of image signal wirings 2 and 2' and a plurality of scanning signal wirings 1 and 1' are provided on the transparent glass substrate 13 so as to intersect each other through the insulating films 8 and 8'. The pixel electrodes 3 and the reverse stagger type thin film transistors 5 for supplying an image signal to the pixel electrodes 3 are provided so as to be matrix-like at respective intersections of the image signal wirings 2 and 2' and the scanning signal wirings 1 and 1'.

[0039]

The scanning signal wiring 1 is formed of a refractory metal

having energy of oxide formation of -300 kcal or more such as tungsten (W), molybdenum (Mo), titanium (Ti), nickel (Ni), or chromium (Cr) or an alloy thereof, or an alloy of a refractory metal such as tungsten (W), molybdenum (Mo), titanium (Ti), tantalum (Ta), nickel (Ni), or chromium (Cr) and aluminum. In case the scanning signal wiring 1 is formed of laminated films, it is sufficient that at least the uppermost layer is formed of a refractory metal or an alloy of a refractory metal and aluminum described in the above.

[0040]

The above insulating film 8 is formed of, for example, a silicon oxide film, while the insulating film 8' is formed of, for example, a silicon nitride film.

[0041]

The image signal wirings 2 and 2' are formed of the high-resistance semiconductor film 6 of amorphous silicon or the like not containing or containing only a small amount of semiconductor impurity, the low-resistance semiconductor film 14 containing a high concentration of semiconductor impurity, a barrier metal film 15, and a transparent conductive film 3 such as ITO. The barrier metal film 15 is formed of a refractory metal such as tungsten (W), molybdenum (Mo), titanium (Ti), tantalum (Ta), nickel (Ni), or chromium (Cr), or an alloy of such a refractory metal and aluminum.

[0042]

The pixel electrode 3 is formed of a transparent conductive

film such as ITO.

[0043]

The thin film transistor 5 is formed of a gate electrode G formed so as to protrude from the scanning signal wirings 1 and 1', a gate insulating film formed of the insulating films 8 and 8', the high-resistance semiconductor film 6 to be a channel region, the low-resistance semiconductor film 14 to be a source electrode S and a drain electrode D, the barrier metal film 15, and the transparent conductive film 3. The thin film transistor 5 is formed of a channel etching type thin film transistor with no etching stopper film formed at a channel portion.

[0044]

The high-resistance semiconductor film 6 to be the channel region of the thin film transistor is preferably formed of a lower semiconductor layer not containing nitrogen element and carbon element and an upper semiconductor layer containing nitrogen element and carbon element. When, in this way, the high-resistance semiconductor film 6 to be the channel region of the thin film transistor is formed of the lower semiconductor layer not containing nitrogen element and carbon element and the upper semiconductor layer containing nitrogen element and carbon element, the high-resistance semiconductor film 6 and the low-resistance semiconductor film 14 can be selectively etched with satisfactory characteristics being maintained. Therefore, the thickness of the high-resistance semiconductor film 6, which, conventionally, has

to be 2500 - 3000 Å, can be made as thin as about 500 - 1000 Å, and the thickness of the image signal wirings 2 and 2' can be made smaller as well, which leads to an improvement in the manufacturing yield.

[0045]

On the transparent glass substrate 12, the black matrix 7 and the opposing electrode 11 are provided. The black matrix 7 is for preventing light leakage between the pixel electrodes 3 adjacent to each other.

[0046]

Band-like light-shielding electrodes 4 and 4' are provided on the transparent glass substrate 13 between the image signal wiring 2 and the pixel electrode 3. The band-like light-shielding electrodes 4 and 4' are formed of a layer at the same level as that of the scanning signal wiring 1. Therefore, light leakage between the pixel electrode 3 and the image signal wiring 6 is prevented as much as possible, and thus, the width of the black matrix 7 on the side of the opposing electrode substrate 12 can be made narrow and the aperture ratio of the portion of the pixel electrode 3 can be improved.

[0047]

By sandwiching the liquid crystal material 10 between the pixel electrodes 3 and the opposing electrode 11 and by selectively supplying an image signal to the pixel electrodes 3 through the

thin film transistors 5, an image is displayed. More specifically, the thin film transistors 5 are turned on by a scanning signal supplied from the scanning signal wirings 1, and an image signal supplied from the image signal wirings 2 is supplied through the source electrodes S and the drain electrodes D to the pixel electrodes 3.

[0048]

As illustrated in Fig. 1, a first short circuit ring wiring 27a and a second short circuit ring wiring 19 are provided in a peripheral portion of a display region X. The scanning signal wirings 1 are connected to the first short circuit ring wiring 27a, while image signal wirings 2 are connected through a transistor 21 for protection against high voltage to the second short circuit ring wiring 19.

[0049]

Next, a method of manufacturing the side of the TFT array substrate of the liquid crystal display device according to the present invention is described with reference to Figs. 5, 6, and 7. In Figs. 5, 6, and 7, 1 denotes the scanning signal wiring, 2 denotes the image signal wiring, 3 denotes the pixel electrode, 4 denotes a band-like light-shielding electrode, 5 denotes the thin film transistor, 6 denotes the high-resistance semiconductor film, 8 and 8' denote the insulating film, 9 denotes the protective film, 10 denotes the liquid crystal material, 13 denotes the transparent glass substrate, 14 denotes the low-resistance semiconductor film,

15 denotes the barrier metal film, 17 denotes an external outlet terminal of the scanning signal wiring, 18 denotes a discharge type connecting portion, 19 denotes the short circuit ring wiring, 20 denotes an external outlet terminal of the image signal wiring, 21 denotes a capacitive coupling type thin film transistor for protection against high voltage, 22 denotes a gate electrode of the thin film transistor 21 for protection against high voltage, and 23 denotes a gate capacitor connecting portion of the thin film transistor 21 for protection against high voltage.

[0050]

Fig. 5 illustrates a manufacturing process of a pixel portion in the TFT array substrate. First, as illustrated in Fig. 5(a), by forming using sputtering or the like on the glass substrate 1 and patterning an aluminum alloy with a refractory metal added thereto or a refractory metal having energy of oxide formation of -300 kcal or less, the wirings 1 and 1' acting both as the scanning signal wiring and as the gate electrode of the thin film transistor 5 are selectively formed. It is to be noted that the band-like light-shielding electrodes 4 and 4' illustrated in Fig. 3 are formed simultaneously with the scanning signal wirings 1 and 1'.

[0051]

Then, as illustrated in Fig. 5(b), after the insulating films 8 and 8' of a two-layer structure, the high-resistance semiconductor film 6, and the low-resistance semiconductor film 14 are formed in succession by plasma CVD or the like, the barrier metal 15 of

a refractory metal or an alloy thereof is formed in succession by sputtering or the like. Using one photomask, the barrier metal 15, the low-resistance semiconductor film 14, and the high-resistance semiconductor film 6 are simultaneously and selectively etched. In the present invention, since a channel etching type thin film transistor is formed, the layer to be the source/drain electrodes can be formed immediately after the layer to be the channel of the transistor.

[0052]

Then, as illustrated in Fig. 5(c), the transparent conductive film of ITO or the like is formed by sputtering or the like. By selectively etching the transparent conductive film 3, the barrier metal 15, and the low-resistance semiconductor film 14 using one photomask, the image signal wiring 2 and the transistor 5 for switching formed of the pixel electrode 3, the high-resistance semiconductor film 6, the low-resistance semiconductor film 14, the barrier metal 15, and the transparent conductive film 3 are formed.

[0053]

Finally, as illustrated in Fig. 5(d), by forming using plasma CVD or the like and patterning the protective film 9 formed of a silicon nitride film or the like, the protective film 9 on the pixel electrode 3 is removed to complete the TFT array substrate.

[0054]

Fig. 6 illustrates a manufacturing process of a portion

around an outlet terminal portion of the scanning signal wiring in the TFT array substrate according to the present invention.

[0055]

First, as illustrated in Fig. 6(a), an end portion of the scanning signal wiring 1 is formed on the substrate 13. This step is the same as that illustrated in Fig. 5(a).

[0056]

Then, as illustrated in Fig. 6(b), the insulating films 8 and 8' of the two-layer structure are formed, and an island-like portion formed of the high-resistance semiconductor film 6, the low-resistance semiconductor film 14, and the barrier metal 15 are formed. This step is the same as that illustrated in Fig. 5(b).

[0057]

Then, as illustrated in Fig. 6(c), a transparent conductive film 16 of ITO or the like is formed on the island-like portion, and the transparent conductive film 16 is etched to be removed so as to be left partially overlapping the scanning signal wiring. This step is the same as the step of forming the pixel electrode 3 illustrated in Fig. 5(c).

[0058]

Then, as illustrated in Fig. 6(d), by forming the protective film 9 of a silicon nitride film or the like and etching to remove a predetermined portion, processing of the portion around the outlet terminal portion of the scanning signal wiring 1 is completed. This

step is the same as that illustrated in Fig. 5(d). By forming the portion around the outlet terminal portion of the scanning signal wiring 1 as described in the above, the discharge type connecting portion 18 is formed. Therefore, when the difference between voltage at the wiring 16 and voltage at the wiring 1 is large, discharge is caused at the exposed portion of the wiring 16 and at the exposed portion of the wiring 1 to prevent destruction of the insulating films 8 and 8' and the like. According to the present invention, since the scanning signal wiring 1 is formed of an aluminum alloy with a refractory metal added thereto or is formed of a refractory metal having energy of oxide formation of -300 kcal or more, even at an end portion 17 of the scanning signal wiring 1, the scanning signal wiring 1 can be connected to an external circuit without covering it with an oxide conductive film such as ITO. More specifically, in a liquid crystal display device or the like, for the purpose of easy connection to an external circuit (such as an IC for driving), connecting an IC for driving to a terminal portion by micro bump bonding has been proposed recently. Since, in micro bump bonding, a pad of an IC for driving and a terminal portion of a signal wiring are connected with the pad and the terminal portion not being bonded but being in contact with each other, ITO or the like which presents conductivity even when oxide is formed is conventionally used. However, according to the present invention, when the scanning signal wiring 1 is formed of a refractory metal having energy of oxide formation of -300 kcal or more, the surface of the scanning signal wiring 1 is hardly oxidized, and, when the

scanning signal wiring 1 is formed of an alloy of a refractory metal and aluminum, even when an oxide film is formed, it can be easily broken through with a pad portion of the IC for driving or the like. Therefore, the terminal portion of the scanning signal wiring 1 has practicability even if it is not covered with an oxide conductive film of ITO. Further, a similar effect can be expected with regard to a conventional connecting method using an anisotropic conductive film. As a result, steps of forming a contact hole for connecting the scanning signal wiring 1 and the oxide conductive film 16 and the like can be omitted. Further, since the protective film 9 and the insulating films 8 and 8' are simultaneously removed, they can be removed in one step.

[0059]

Fig. 7 illustrates a manufacturing process of a portion around an outlet terminal portion of the image signal wiring 2 in the TFT array substrate of the liquid crystal display device according to the present invention.

[0060]

First, as illustrated in Fig. 7(a), the gate electrode 22 of the transistor 21 for protection against high voltage is formed. The gate electrode 22 is the same as the step illustrated in Fig. 5(a).

[0061]

Then, as illustrated in Fig. 7(b), the insulating films 8

and 8' of the two-layer structure are formed, the high-resistance semiconductor film 6, the low-resistance semiconductor film 14, and the barrier metal film 15 are formed, and end portions of the high-resistance semiconductor film 6, the low-resistance semiconductor film 14, and the barrier metal film 15 are etched to be removed. This step is the same as that illustrated in Fig. 5(b).

[0062]

Then, as illustrated in Fig. 7(c), the transparent conductive film 16 is formed, and part of the transparent conductive film 16, the barrier metal film 15, and the low-resistance semiconductor film 14 are removed. This step is the same as that illustrated in Fig. 5(c).

[0063]

Then, by forming the protective film 9 of a silicon nitride film or the like and removing part of the protective film 9, the external outlet terminal 20 of the image signal wiring 2 is formed, and at the same time, the capacitive coupling type thin film transistor 21 for protection against high voltage is formed. More specifically, the transistor 21 is formed of the gate electrode 21, the insulating films 8 and 8', the semiconductor film 6, the source electrode S, and the drain electrode D. In this case, the gate electrode G and the source electrode S are capacitively coupled.

[0064]

Therefore, there is no need to provide a contact hole for connecting the source electrode S and the gate electrode G in the insulating films 8 and 8'.

[0065]

As described in the above, the TFT array substrate of the liquid crystal display device according to the present invention can be formed by each four photolithography steps with regard to the portion of the pixel electrode 3, the terminal portion of the scanning signal wiring 1, and the portion of the transistor 21 for protection against high voltage.

[0066]

In the above embodiments, the scanning signal wiring 1 and the short circuit wiring 16 are structured so as to be connected by discharge. However, it may be that, in the step illustrated in Fig. 6(a), the end portion of the scanning signal wiring 1 is left unremoved, a mask is provided at the end portion, the insulating films 8 and 8', the low-resistance semiconductor film 6, the high-resistance semiconductor film 14, and the barrier metal film 15 in Fig. 3(b) are formed, and then the mask is removed to form the transparent conductive film 16. In this way, by using a mask, the scanning signal wiring 1 and the short circuit wiring 16 can be directly connected without complicating the process.

[0067]

[Effect of the Invention]

As described in the above, according to a liquid crystal display device of the present invention, a thin film transistor is a channel etching type, an insulation protective film is formed so as to cover the thin film transistor and image signal wiring, part of the image signal wiring is exposed at an outlet terminal portion of the image signal wiring, part of scanning signal wiring is exposed at an outlet terminal portion of the scanning signal wiring, and a surface layer of the scanning signal wiring is formed of an aluminum alloy with a refractory metal added thereto or is formed of a refractory metal having energy of oxide formation of -300 kcal or more. Therefore, the number of photolithography steps is decreased to be four, the manufacturing process is simplified, the manufacturing cost is lowered, and the manufacturing yield is improved.

[0068]

Further, according to a method of manufacturing a liquid crystal display device of the present invention comprising the steps of providing an aluminum alloy with a refractory metal added thereto or a refractory metal having energy of oxide formation of -300 kcal or more as a surface layer of scanning signal wirings, providing the scanning signal wirings and image signal wirings so as to intersect each other through an insulating film, providing pixel electrodes and reverse stagger and channel etching type thin film transistors for supplying an image signal to the pixel electrodes so as to be matrix-like at intersections of the image signal wirings and the

scanning signal wirings, forming an insulation protective film so as to cover the thin film transistors and the image signal wirings, and injecting a liquid crystal material between said pixel electrodes and an opposing electrode provided so as to be opposed to the pixel electrodes, since patterning of the protective film on the pixel electrodes, patterning of the protective film on the outlet terminals of the image signal wirings, and patterning of the protective film and the insulating film of the outlet terminal portions of the scanning signal wirings are carried out simultaneously, the number of photolithography steps is decreased to be four, the manufacturing process is simplified, the manufacturing cost is lowered, and the manufacturing yield is improved.

[Brief Description of the Drawings]

[Fig. 1] A view illustrating a TFT array substrate of a liquid crystal display device according to the present invention.

[Fig. 2] An enlarged view of a pixel of the liquid crystal display device according to the present invention.

[Fig. 3] A sectional view taken along the line A-A' in Fig. 1.

[Fig. 4] A sectional view taken along the line B-B' in Fig. 1.

[Fig. 5] Sectional views illustrating manufacturing steps in order of a pixel portion.

[Fig. 6] Sectional views illustrating steps around an outlet terminal of scanning signal wiring.

[Fig. 7] Sectional views illustrating steps around an outlet terminal

of image signal wiring.

[Fig. 8] A view illustrating a conventional TFT array substrate of a liquid crystal display device.

[Fig. 9] An enlarged view of a pixel of the conventional liquid crystal display device.

[Fig. 10] A sectional view taken along the line A-A' in Fig. 8.

[Fig. 11] A sectional view taken along the line B-B' in Fig. 8.

[Fig. 12] Sectional views illustrating manufacturing steps in order of a pixel portion.

[Fig. 13] Sectional views illustrating steps around an outlet terminal of scanning signal wiring.

[Fig. 14] Sectional views illustrating steps around an outlet terminal of image signal wiring.

[Description of Numerals]

1, 31 ... scanning signal wiring, 2, 32 ... image signal wiring, 3, 33 ... pixel electrode, 4 ... band-like light-shielding electrode, 5, 35 ... thin film transistor, 6, 36 ... high-resistance semiconductor film, 7, 37 ... black matrix, 8, 38 ... gate insulating film, 9, 39 ... protective film, 10, 40 ... liquid crystal material, 11, 41 ... opposing electrode, 12, 13, 42, 43 ... transparent glass substrate, 14, 44 ... low-resistance semiconductor film, 15 ... barrier metal film, 16 ... transparent conductive film, 17, 47 ... external outlet terminal of scanning signal wiring, 18 ... discharge type connecting portion, 19, 49 ...

short circuit ring wiring, 20, 50 ... external outlet terminal of image signal wiring, 21 ... capacitive coupling type thin film transistor for protection against high voltage, 22 ... gate electrode of thin film transistor 21 for protection against high voltage, 23 ... gate capacitor connecting portion of thin film transistor 21 for protection against high voltage, 34 ... etching stopper film, 45 ... metal film, 51 ... thin film transistor for protection against high voltage, 52 ... gate electrode of thin film transistor 51 for protection against high voltage, 53 ... electrode junction portion of thin film transistor for protection against high voltage.